(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 139 565**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 84401875.4

(22) Date of filing: 21.09.84

(51) Int. Cl.⁴: F 16 L 15/04
E 21 B 17/042, F 16 L 15/00

(30) Priority: 26.09.83 US 535621

(43) Date of publication of application:
02.05.85 Bulletin 85/18

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

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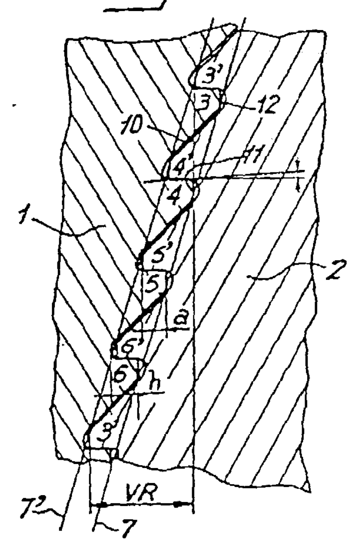
(54) **Conical thread configuration for rapid make-up connection.**

(57) A conical thread configuration for providing strong simple and rapid make-up connection of a pin (2) and a box members (1) particularly for connecting sections of pipes, casings and conductor pipes, anchoring pipes, wellheads and risers, particularly for offshore oil production, wherein each member having a plurality of (n) thread lead entries, (n) being at least equal to two and wherein the radial dimension (a) of the engaged thread overlap after make-up is smaller than the radial thread height (h) and smaller than half of the variation (VR) of the radius of said frusto-conical surface (7,7') on one thread pitch and larger than (1/2n) of said variation (VR).

Fig. 3



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Croydon Printing Company Ltd.

The invention pertains to tubular connections, comprising a pin and box members mechanically interlocked in each other.

The object of the invention is to provide a strong, simple and extremely fast make-up connection, between sections of pipes of various diameters particularly suitable in the drilling industry to connect well casings, well conductor pipes, offshore platforms anchoring piles, wellhead to wellhead receptacle or B.O.P. stacks and offshore drilling risers.

In the early 60's Oil exploration and production went offshore and the limitations of the technical possibilities of standard A.P.I. threaded or flange connections were outlined by the increase in diameter of the connection required in offshore operation, the requirement of being able to remotely make-up and disconnect underwater connection, and the motions of the floating support where most of the offshore operations were taken place. Also the cost of field welding widely used onshore to connect sections of large pipe, become prohibitif due to the high hourly cost of offshore operations. In these early days, three types of connectors were introduced to solve these problems:
First, a specialized generation of thread connector were designed, using modified A.P.I. conical thread,to extend the use of threaded casing connection larger than 16" for operation from floating support. These threaded connectors are still widely used today, for dimensions below 24", despite the requirement of a minimum of two and a half turn rotation for make-up.

This rotation is commonly achieved either by the use of a hydraulic actuated power tong, said power tong requiring specialized crew to be operated, or the conventional "rope technic", said technic consisting of pulling on a soft rope from the drilling rig main winch capstan, said rope being rigged three to five turns around the add-on casing piece body, said pull approaching by rotation the pin

and box members. Final make-up torque is reached by the use of a mechanical tong, said mechanical tong consisting of a large chain wrench having a lever extending radially to multiplicate the torque generated by the cathead chain hooked on the end of said lever, said cathead chain having the other end pulled by said drilling rig main winch.

Maximum amount of rotation achieved in one stroke of said mechanical tong/cathead chain assembly is around one quarter to one third of a turn without, having to reset said assembly by manual reverse rotation

A second connector for the larger diameter casing, threadless, was also introduced based on a snap-ring linkage. This "snap-ring type" connector offers fast make-up but does offer neither the low weight to capacity ratio, neither the rigidity, nor the price competitiveness of the threaded connector for a given capacity.

A third connector, featuring radial dogs, was introduced to replace flange connections, in a mechanical configuration for drilling riser connections, and in a hydraulic configuration for wellhead connections.

Recently, the use of dog type connectorshas been extended to offshore platform anchoring pile connection, but its success has been limited, by its high cost, due to the large number of parts and heavy section required in the design and manufacturing of such a connector.

In the 70's, two other types of connectors were introduced :

First, a "L type" connector,featuring large dimensions threads or circular grooves, cylindrical or conical, said threads or grooves being milled out on a least two sections limited by cylindrical or conical generatrix, in order that make-up of the connector can be achieved by axial stabbing, followed by a rotation of a fraction of a turn to bring the remaining portions of threads or grooves in an interlocking configuration. The make-up rotation is limited to a maximum of a quater of a turn.

The major drawback of this connector, despite the fast make-up characteristics, is the cost of manufacturing, due to the extensive milling operation and the capacity to weight ratio, due to the removal of 50 % of the loading surfaces.

The second connector is a no rotation "interference type" connector mainly designed for permanent application such as offshore platform conductor pipe or anchoring pile. It presents the major drawbacks of not being disconnectable and requiring a special bulky hydraulic clamping unit, operated by specialized crew, for making-up.

The present invention provides a conical thread configuration for the connection of casing, conductor pipe, anchoring pile, wellhead and risers, comprising pin and box members, wherein each member having a plurality of (n) thread lead entries, n being at least equal to two and wherein the radial dimension (a) of the engaged thread overlap after make-up which is smaller than the radial thread profile height (h) and is smaller than half of the variation (VR) of the radius of said frusto-conical surface on one thread pitch and larger than $\frac{1}{2}$ of said variation (VR).

Moreover the number n of thread head entries is preferably atmost equal to $(AD)x(p)x \frac{1}{6,25}$

in which : - (AD) is the average diameter of the frusto-conical surface bearing the threads (in inches)

- (p) is the number of threads per inch.

The immediate result of the invention is the possibility, after stabbing the pin and box members, to obtain full make-up of the pin and box threads by only a rotation of a fraction of a turn, while the entire lenght of threads is fully engaged over the entire periphery of the interlocking surfaces, since in the preferred case, each thread extends over more than one turn. This said fraction of a turn make-up being at most one half of a turn, and at least one half of a turn divided by (n).

The conical thread configuration, according to the invention, combines the advantage of th "L type"

connectors, i.e. featuring complete make-up by axial stabbing followed by a rotation of a fraction of a turn, without having the drawback thereof,namely,the low capacity on weight ratio and high manufacturing cost, and the advantage of the specialized threaded connector, i.e. high capacity on weight ratio and low manufacturing cost, without having the drawback of requiring power tong or even the rope phase since in the preferred case, only one stroke of the mechanical tong/cathead chain assembly is required to fully make-up the connector.

The fraction of a turn make-up allows the thread configuration of the invention to be used in numérous types of connection,whether they are made-up manually or by means of hydraulic cylinders for remote control.

In a particular embodiment, the box member may serve as means for connecting a wellhead connector on a wellhead housing. In this case, the pin member may be the wellhead housing with (n)threads on its conical outer upper part. The box member is swivelling on the stationnary wellhead connector body, said body is receiving hinged hydraulic cylinders, said cylinders include rods connected to the box member in order to drive said box member in rotation with regard to said stationary wellhead connector body.

This feature is very relevant of the invention, since only the known rigid "dog type" connector box assembly has been successfully remotely controlled by the addition of a cam ring operated by vertical hydraulic cylinders said "dog type" connector box assembly comprises numerous parts beside the cylinders : dogs, cam, ring, etc... while the remotely actuated connector according to the invention has a box assembly which comprises only two parts: the wellhead connector body and the swivelling box member beside the cylinder.

A conical thread configuration, according to the invention, where the number of thread lead entries

can increase with the diameter while retaining the self-locking characteristics of low angle spiral threads, allows to limit the peripheral . displacement of the box member with regard to the pin member while being stab with the proper orientation, to less than 30" in the preferred case.

This feature permits for connecting large section of pipe and ,in particular,offshore platform anchoring pile, said anchoring pile ranging from 30" to 96"'in diameter, the possible use a tightening device comprising a 10 tons, 20" stroke hand carried, hydraulic cylinder and a belt of length equal to four times the connector diameter, said cylinder being bolted on the pin member in a cantilevered position, approximatively at the level of the pin/box outside boundary, the rod of said cylinder extending radially away from the members axis, said rod including a fork with a roller, said roller having its axis parallel to the connector axis, said belt is wrapped around the connector approximatively at said pin/box boundary level, said belt being bolted respectively to the pin and box members, said bolts being located close to the pin/box boundary to minimise the angle of helicoïdal shape of the belt, said belt passing over said roller, so that when pressurised fluid is injected into said cylinder, the said rod extends and tensions said belt which rotates the connector members with regard to each others to obtain make-up or disconnection of said connector.

The thread profile according to the invention can be of many different types. For example, in a first embodiment, the thread profile features several adjacent grooves, said grooves having the same radius and identical variation of radius along the conical helix of said thread. In another embodiment, the thread profile may be triangular or trapezoidal.

The invention will be more readilly understood by reading the following description with reference to the following accompanying drawings :

Fig. 1 is a view in elevation of the connector according to the invention before stab-in.

Fig. 2 shows partial sectional view of the connector after stab-in.

Fig. 3 is an enlarged partial view after make-up in a non interference type connector.

Fig. 4 is a partial enlarged view of a variant of Fig. 2.

Referring now to the drawings, the connector of figs. 1 to 4 comprises a box member 1 and a pin member 2. In the example shown, the members are connected by means of four threads 3,4,5 and 6 for the box, and 3',4',5' and 6' for the pin 1.

In the figure 3, the threads are shown engaged, the thread profile of the box 1, in an axial plane, comprises a stabbing flank 10, and a load flank 11 slightly raising toward the connector axis, both flank 10 and 11 being linked on one thread by a vertical thread crest 12. The thread profile of the pin 2 is identical to the thread profile of the box 1.

Each thread of the box 1 is cut out of a conical surface 7, each thread of the pin 2 being cut out of a conical surface 7'. When stabbing the box member 1 over the pin member 2, on figure 4, the thread 3 of the box 1 just clears the crest of the thread 3' of the pin 2 and the stabbing flank 10 of the thread 3 lands on the stabbing flank 10 of the thread 4'.

Since there are four threads, a rotation of a quarter of a turn of the box, the pin staying stationary, decreases the radius of the thread 4 of the box, said thread 4 slides on its stabbing flank 10, upwardly toward the member axis, until the load flank 11 of the thread 4 and 4' get in contact.

On the figure 3 the dimension (a) represents the radial dimension of the engaged thread overlap and is smaller than the radial height (h) of the thread profile.

According to the invention, this dimension (a) is smaller than half of the variation (VR) of the radius of the conical surface 7 or 7' bearing the thread per one pitch. With this relationship, it is ensured that, independantly of the number of thread lead entries, it will need at most half of a turn to disengage the threads from the tight make-up position to the position where an actual separation of the members is possible.

In the embodiment of figure 3, the dimension (a) is equal to the quarter of the variation (VR) and since they are four threads , only a quarter of a turn is needed to fully disengage the two members.

It should be pointed out that, in the case of figure 3, (n)times the projection of one engaged thread overlap on a radial plan, correspond exactly to the envelop of the projection of the engaged thread overlaps of all the threads. As a matter of fact, projection of engaged thread 4,4' overlap is exactly adjacent to projection of engaged thread 3,3' overlap and engaged thread 5,5' overlap, after rounding up functional clearances and machining tolerances. The ratio between the addition of the projected engaged thread overlaps of each thread, and the envelop of the projection of the engaged thread overlaps of all the threads is a relevant criteria of the capacity of the connection.

So, if (a) is equal to $\frac{(VR)}{(n)}$, (n) being the number of thread lead entries, the above defined ratio is equal to 1, preferred value of the invention for diameterslarger than 16".

In case, (a) is greater than $\frac{(VR)}{n}$, the above defined ratio is greater than 1 and the disconnection rotation is more than $\frac{1}{(n)}$ turn. On another hand, with (a) smaller than $\frac{(VR)}{n}$ the above defined ratio is smaller than 1 and the disconnection rotation less than 1/n turn. Generally, it is not recommended to select a value for (a) smaller than $\frac{(VR)}{2n}$

since in this case, the total of the engaged thread overlap surfaces is less than one half of the projected envelop and the mechanical capacity of the connection is greatly reduced.

It can be deducted from the above, that by increasing the number of thread lead entries, the rotation angle to make-up the connection can be reduced but ,for given diameter and dimension of thread, this number cannot be increased indefinitely without compromising the self-locking caracteristic of the connection. In order to stay below the minimum friction coefficient of steel to steel lubricated surfaces of 0.06 it is recommended to limit the number of thread lead entries to less than

$$\frac{(A\ D) \times (p)}{6.25}$$

in which :

(A D) is the average diameter of the frusto conical surface bearing the threads in inches.

(p): number of threads per inch.

An example of the preferred configuration is for (AD)= 20" and p = 2.5, which leads to $2 \leqslant \underline{n} \leqslant 8$. The frusto-conical height will be sufficient, on each member 1 and 2 to allow a thread to intersect at least twice a determined generatrix of the frustoconical surface.

Connector members sealing may be ensured with the aid of well-known O-rings. An O-ring 8 has been shown in one groove of member 2. At the end of connection by rotation, the O-ring 8 slides on the vertical part 9 of the member 1.

To reduce the make-up rotation to a value close to the release rotation, a mark 13 can be located on the box 1. This mark will be lined-up with a milled portion 14 of the surface 17.

On figure 2, it can be seen that a cylindrical surface 15 terminates the conical thread on the entry end of the box member 1. Similarly, a cylindrical surface 16 terminates the threaded part of the pin member 2. Said surfaces 15 and 16 are used for mutual axial alignment of the two members and to achieve this, the surface 15 rides

on a mating surface 17 of the member 2 and the surface 16 rides on a mating surface 9 of the member 1. Figure 5 shows that mating surface 9 of figure 2 is in fact an interrupted cylindrical surface 18 being,the result of truncating the crests of the threads of the box member on the area 19. An acceptable alignment is only possible if the number of the thread lead entries is at least equal to three. So the surface 16 while engaging into the area 19, finds always at least three centralizing alignment points.

It will be understood that a similar arrangement can be located between surfaces 15 and 17.

WHAT I CLAIM IS :

1. A conical thread configuration for providing strong simple and rapid make-up connection of a pin and a box members particularly for connecting sections of pipes, casings and conductor pipes, anchoring pipes, wellheads and risers, particularly for offshore oil production, wherein each member having a plurality of (n) thread lead entries, (n) being at least equal to two and wherein the radial dimension (a) of the engaged thread overlap after make-up is smaller than the height (h) of the radial thread profile height and smaller than half of the variation (VR) of the radius of said frusto-conical surface on one thread pitch and larger than $(\frac{1}{2n})$ of said variation (VR).

2. The configuration of claim 1 wherein the number (l) of thread lead entries is at most equal to $(AD)\times(p)\times\frac{1}{6,25}$ in which :

- (AD) is the average diameter of the frusto-conical surface bearing threads (in inches),
- (p) is the number of threads per inch.

3. The configuration of claim 1, wherein each thread intersects at least twice a determined generatrix of said frusto-conical surface.

4. The configuration of claim 1, wherein each thread includes a load flank and a stabbing flank and when the pin member is located under the box member, each load flank offers a slope raising towards the axis of the members.

5. The configuration according to claim 1, wherein the number of thread lead entries being at least equal to 3, each of said pin and box members includes one cylindrical surface terminating the threaded section on the stab-in end, said cylindrical surface of one member riding, for members alignment, prior to make-up rotation, on a mating surface of the second member, at least one of said mating surface being an end section of said threads, said section having the thread crests truncated cylindrically.

6. The configuration according to claim 5 when said at least one of mating surface is located into the box member.

Fig. 1

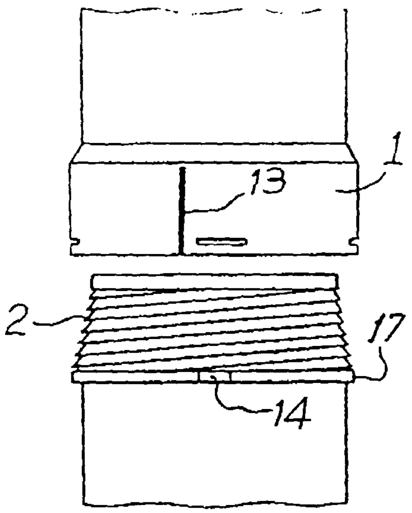


Fig. 2

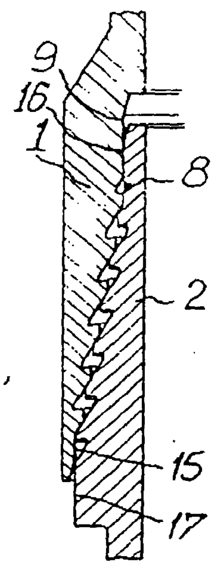


Fig. 3

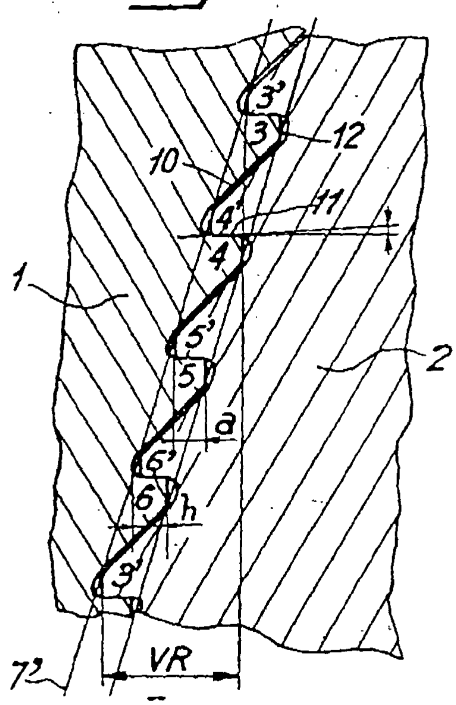
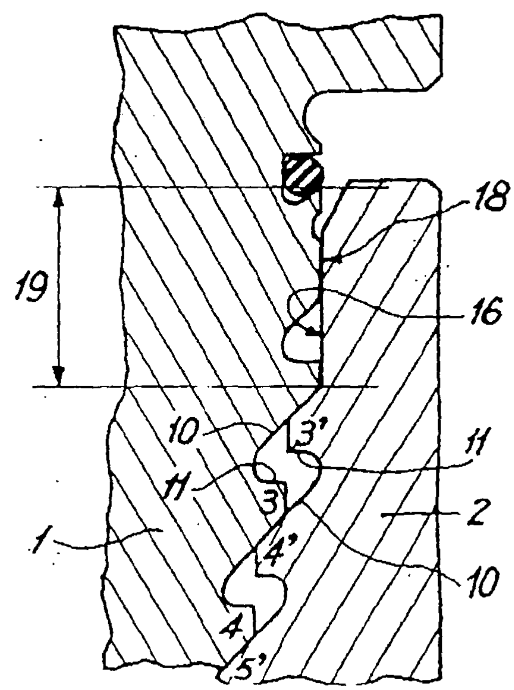


Fig. 4



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EUROPEAN SEARCH REPORT

Application number

EP 84401875.4

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US - A - 4 346 920 (DAILEY) * Fig. 3 * --		F 16 L 15/04 E 21 B 17/042 F 16 L 15/00
A,P	FR - A1 - 2 529 991 (NOBILEAU) * Fig. 1-6; abstract * ----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			F 16 L 15/00 E 21 B 17/00 E 21 B 19/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	10-12-1984	SCHUGANICH

CATEGORY OF CITED DOCUMENTS

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